



# ESD A-TRAIN OVERVIEW

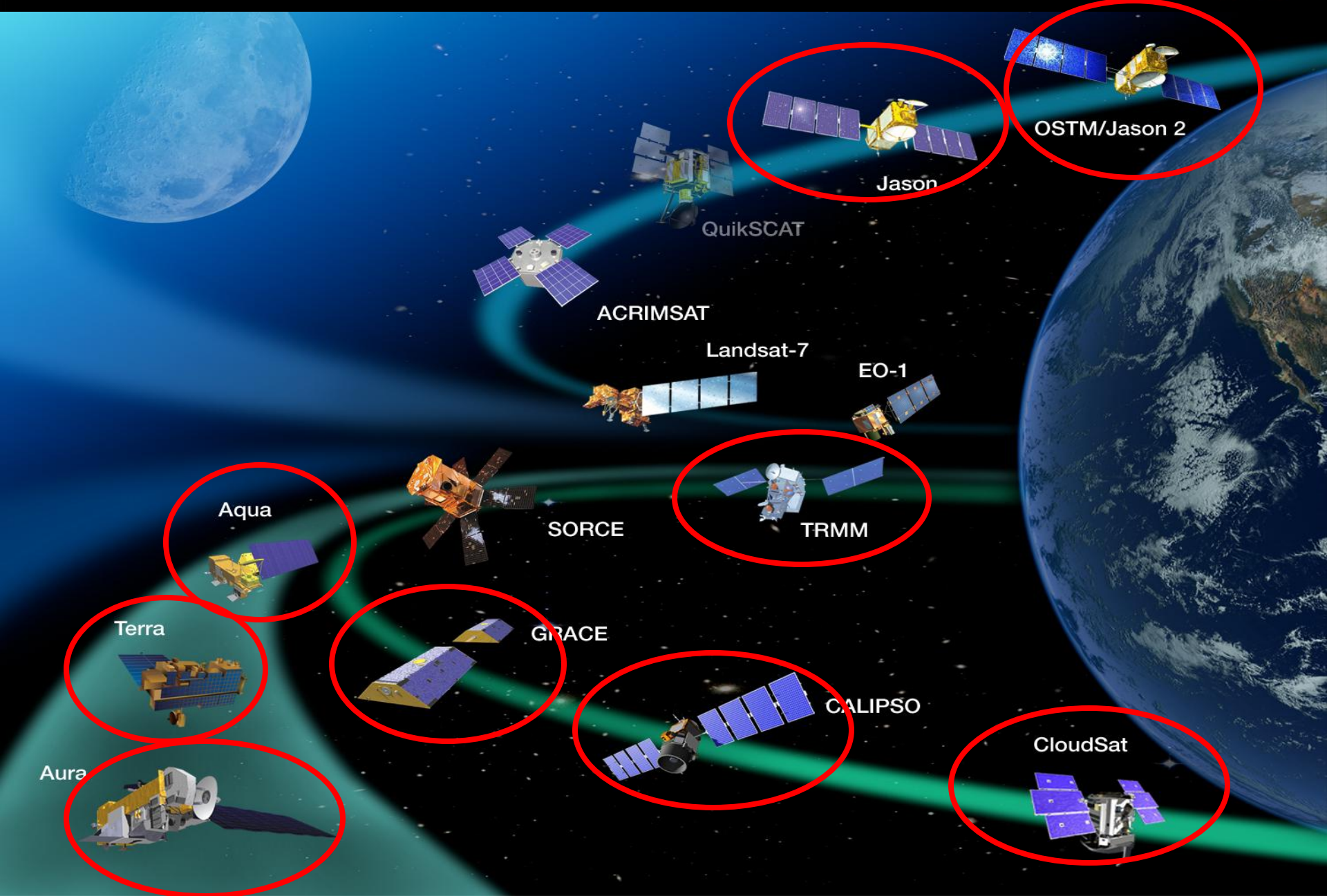
Michael H. Freilich  
26 Oct 2010

# International Sustained Science Synergy Students





# NASA Operating Missions (International Collaboration)



OSTM/Jason 2

Jason

QuikSCAT

ACRIMSAT

Landsat-7

EO-1

Aqua

SORCE

TRMM

Terra

GRACE

CALIPSO

CloudSat

Aura

# International Sustained Science Synergy Students





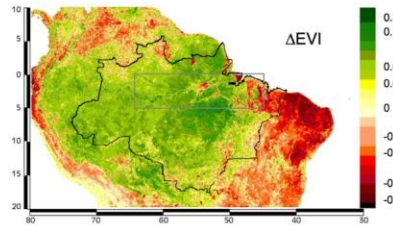
# International Sustained Science Synergy Students



# Earth SCIENCE Division Focus Areas



Basin-wide greening in dry season  
October EVI (dry season) minus June EVI (wet season)



Atmospheric Composition

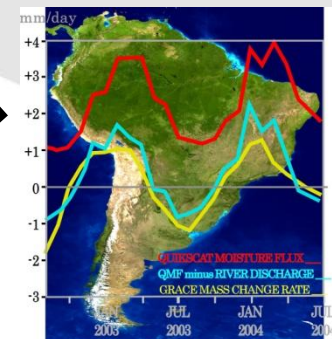
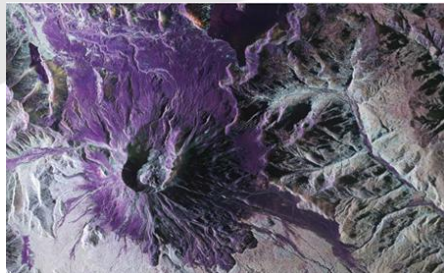
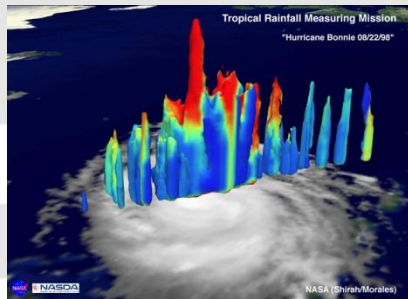
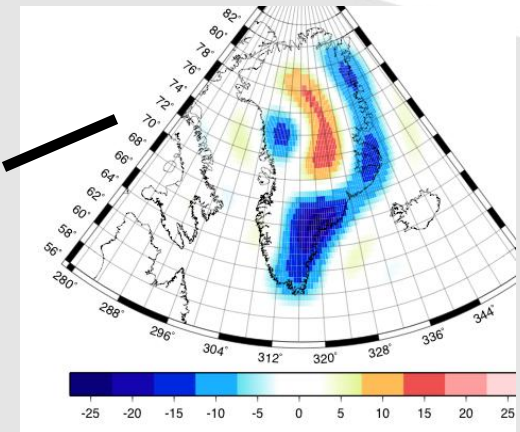
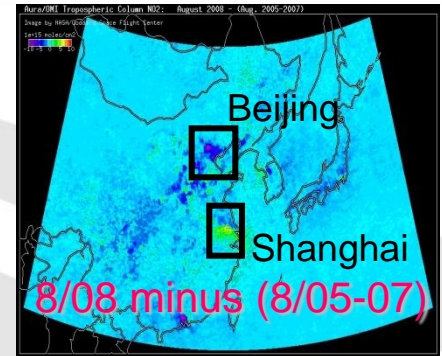
Carbon Cycle and Ecosystems

Climate Variability and Change

Weather

Water and Energy Cycle

Earth Surface and Interior

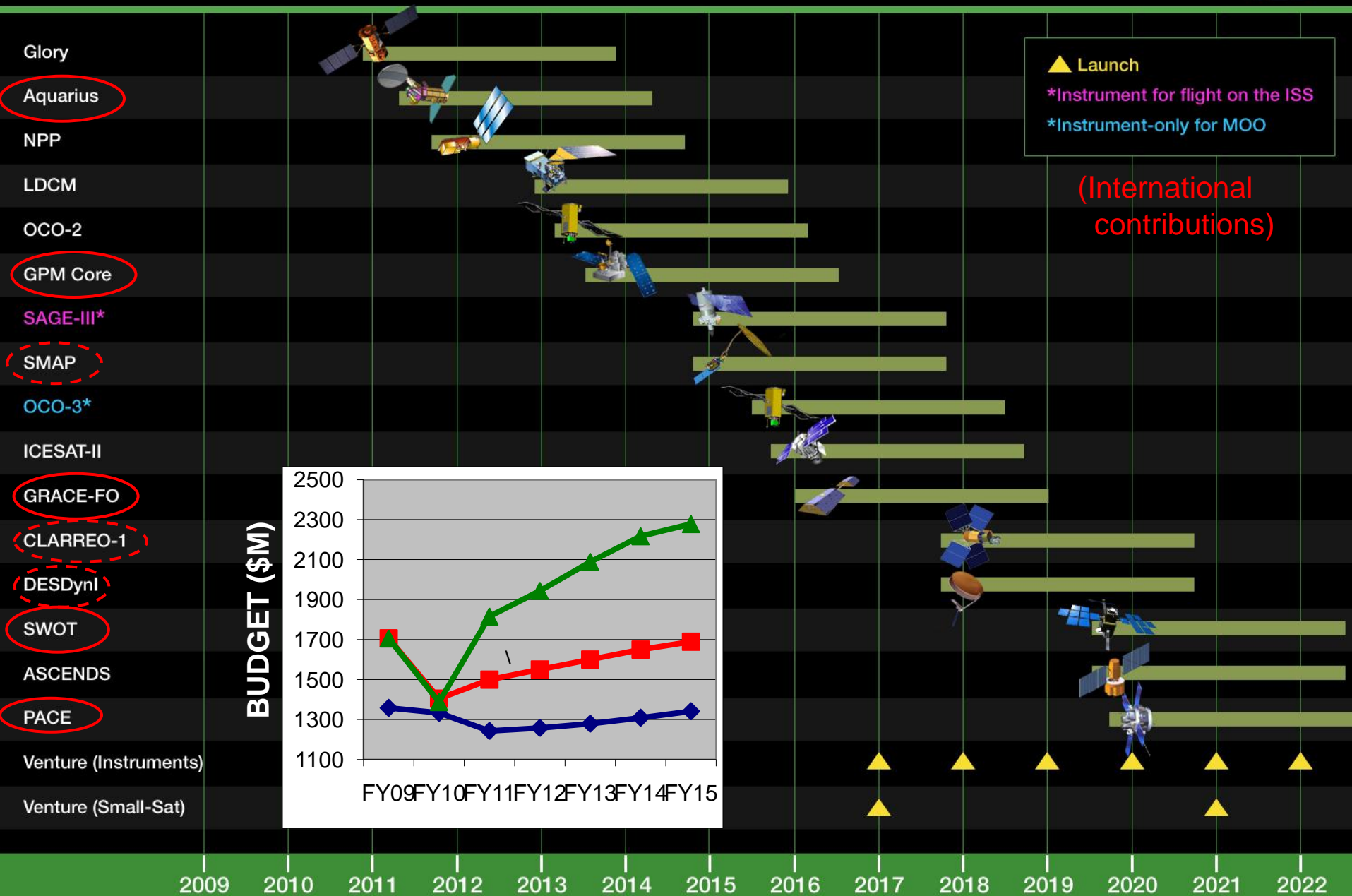




# International Sustained Science **Synergy** Students



# Future Orbital Flight Missions – 2010 – 2022





# Integrated Program for Water Availability/Quality

- Precipitation
  - TRMM (extended mission w/JAXA); Field Campaigns (e.g. GRIP, EV-1 Hurr. & Severe Storm Sentinel [HS3]); GPM (7/2013 w/ JAXA)
- Soil Moisture and Freeze/Thaw State
  - SMAP (11/2014 w/CSA)
- Inland Waters
  - SWOT (late 2019 w/CNES, CSA)
- Subsurface Ground Water (Aquifer Volume Changes)
  - GRACE (extended mission w/ Germany); GRACE-FO (2016 w/ Germany)
- Glacier and Ice Sheet Volume Changes and Dynamics
  - ICEBRIDGE (ongoing); ICESAT-2 (10/2015); DESDynI (2017)
- Coastal Water Quality
  - PACE (2019/2020 w/ CNES [likely])
- Northern Latitude Land, Lakes, Permafrost
  - EV-1 CARVE, SMAP, SWOT, GRACE-FO, DESDynI, ICESAT-2
- Accelerated Operational Use of Research Measurements, ...

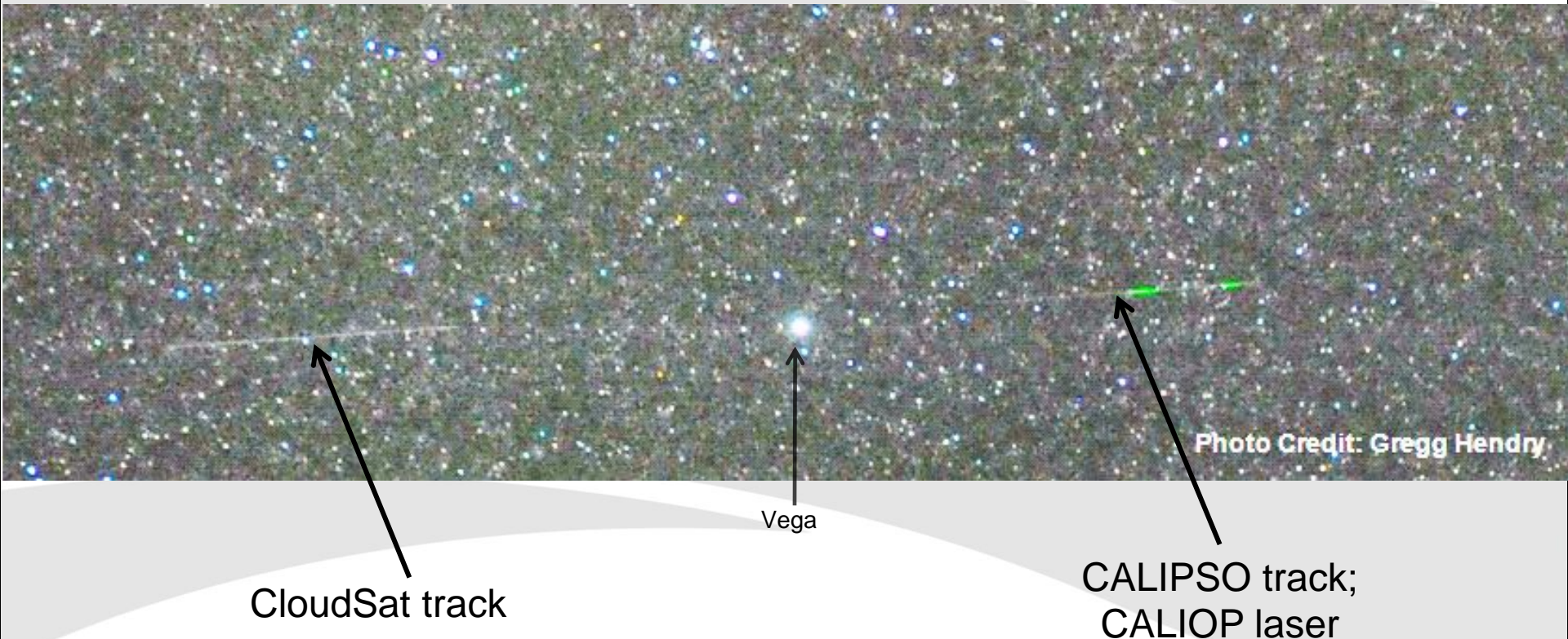
- Based on existing Carbon Cycle and Ecosystem R&A Focus Area
- Global Measurements of Atmospheric CO<sub>2</sub>
  - OCO-2 (2/2013)
  - OCO-3 (2015; instrument for flight of opportunity)
  - ASCENDS (2019-2020)
- Global Measurements of Terrestrial Aboveground Biomass
  - ICESAT-2 (2015; supporting lidar measurements)
  - DESDynI radar/lidar (2017)
- Global Measurements of Oceanic Productivity
  - VIIRS(?) (2011/NPP, 2015/JPSS)
  - PACE (2019; ocean-optimized radiometry, polarimeter)
- Development, Evaluation, and Evolution of Observationally-Based Carbon Products
  - Sustained Pilot Projects



# International Sustained Science Synergy **Students**



# CloudSat and Calipso in the A-Train



*Taken at 5/28/09, 3am local, 6 sec exposure; track visible because satellites illuminated while surface still in darkness*



# OUR RESPONSIBILITY



- What we do in Earth Science is now understood by the public and national leaders to be **IMPORTANT**, not simply interesting and challenging.
- The world is looking to us to **LEAD** and to **SUCCEED**.
- We must organize and work so that everything we do supports:
  - Communicating what we are doing, why we are doing it, and what/when the outcome will be;
  - Achieving technical and substantive success in our specific scientific and applications activities;
  - Clearly articulating what we have discovered or demonstrated, and the implications; and
  - Responding as possible to societal needs as well as scientific imperatives

# BACKUP





- **European Space Agency**

- NASA-ESA Earth Science collaboration framework signed September 2010 (Weiler-Liebig)
- Field Campaigns/Cal-Val; Ground systems, data products, mission “interoperability”; Flight missions

- **ISRO (India)**

- Oceansat-2 scatterometer, ocean color instrument data exchange, validation
- QuikSCAT re-orientation to allow use as transfer standard

- **CNES (France)**

- SWOT (72/28 \$\$, work package agreed upon, Weiler/d’Escatha)
- Polder-FO (polarimeter) for PACE under discussion

- **CSA (Canada)**

- SMAP (Flight components, ground station under discussion; validation)
- SWOT (Flight components; science participation)



- **CONAE (Argentina)**
  - COSMIC real-time data provision (w/ NOAA)
  - SAC-D/Aquarius full mission collaboration
- **JAXA (Japan)**
  - TRMM, ASTER, AMSR-E extended missions
  - ALOS-TDRSS operational data transmission continues until Jan 2011
  - GOSAT/ACOS/OCO-2 (validation, OCO-2 algorithm refinement)
  - GPM
- **DLR/GFZ (Germany)**
  - GRACE extended mission
  - GRACE-FO productive discussions, same workshare as GRACE
  - DESDynI Radar unlikely but under discussion
- **INPE (Brazil)**
  - GPM Low-Inclination Orbiter discussions increasing

# KEY INTERAGENCY INTERACTIONS



- **USGCRP (Global Change Research Program)**
  - Freilich is USGCRP Vice-Chair – Integrated Observations Lead
  - Jack Kaye is ex-Acting USGCRP Chair, Integrated Strategic Planning Team member, NASA Principal
  - NASA is a major contributor to the National Climate Assessment activity
- **JPSS (Joint Polar Satellite System – ex-NPOESS)**
  - JASD Lead, coordinates with ESD
  - ESD NPP mission will be used operationally after launch for JPSS
  - Significant issues with DoD
- **USGS/DOI**
  - Landsat follow-on under discussion (reimbursable – will be JASD execution)



# NON-FLIGHT RESEARCH AND APPLICATIONS ACTIVITIES



The FY2011 budget augmentation enables several key research, applications, technology, and education activities to be initiated or greatly expanded. These non-flight activities both enable the new space missions and provide the scientific and societal benefits from the spaceborne measurements.

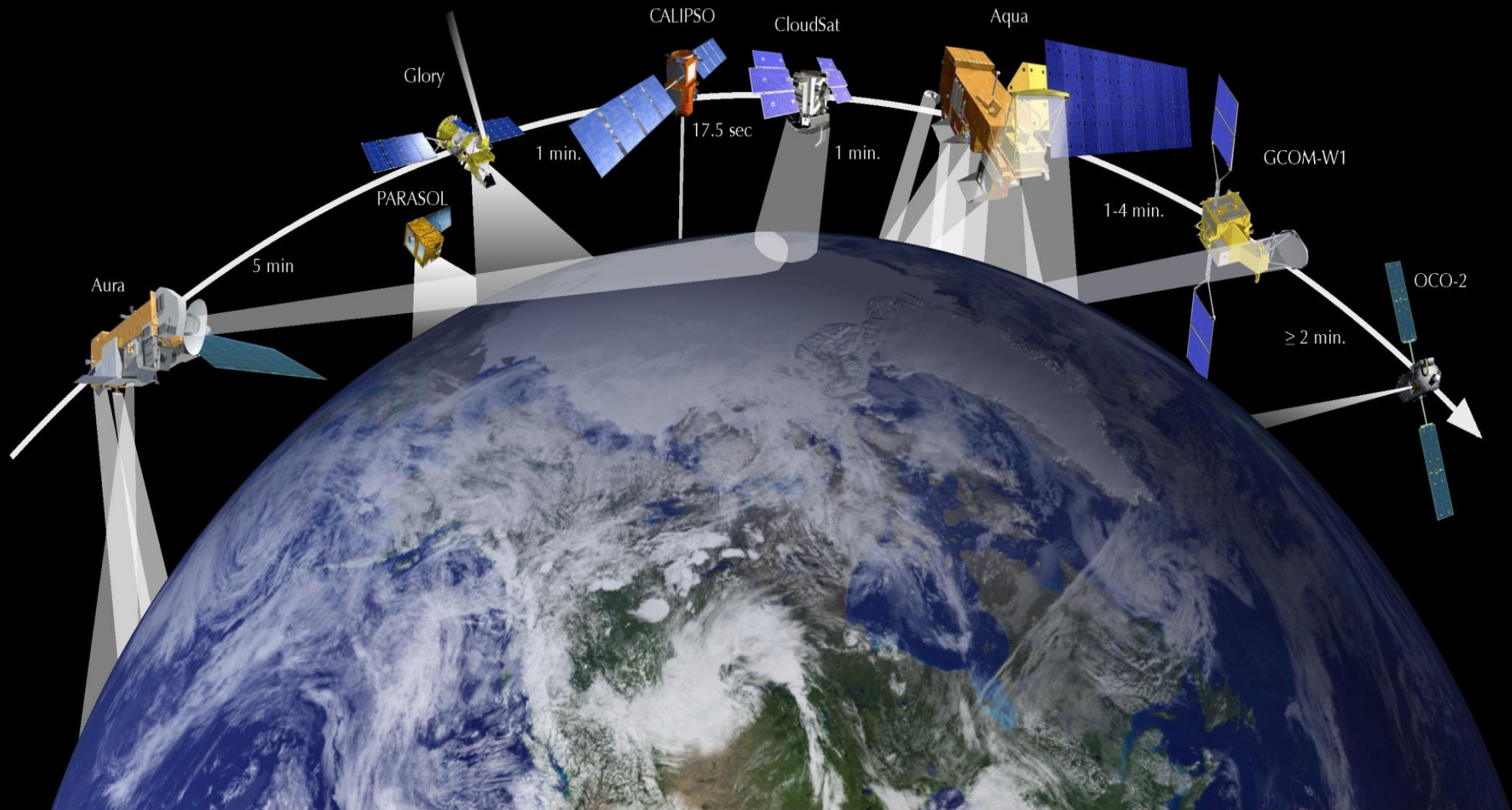
- Modeling, assessment, and computing activities to expand NASA's contribution to the 2013 National Assessment by the USGCRP and the next mitigation and adaptation (Working Group II) assessment of the IPCC;
- Acceleration of operational use of NASA research data to improve climate prediction and weather forecasting, including expansion of SERVIR to additional nodes in strategic locations in the developing world in collaboration with USAID, and expansion of the sources and types of information products available to and from SERVIR nodes;
- Synthesis of NASA Earth Science observations via expanded opportunities for competitively-selected Interdisciplinary Science investigations and key mission science team work;
- Calibration of multi-satellite global data sets to enable increasing leverage of international data contributions, furthering the goals of USGEO and GEOSS;
- Development of NASA's contributions to a national Carbon Monitoring System in collaboration with other federal agencies;
- Expanded Earth Science Technology Program to provide the technology advances needed to enable accelerated implementation of Decadal Survey Tier 2 & 3 missions;
- Commensurate investment in Earth Science education programs such as GLOBE to assure that new Earth science understanding is infused in the nation's education curricula and that an educated workforce and populace is equipped to use the results of NASA's Earth Science program.

# Earth Science Division Overview



- Overarching goal: to advance Earth System science, including climate studies, through spaceborne data acquisition, research and analysis, and predictive modeling
- Six major activities:
  - Building and operating Earth observing satellite missions, many with international and interagency partners
  - Making high-quality data products available to the broad science community
  - Conducting and sponsoring cutting-edge research
    - Field campaigns to complement satellite measurements
    - Analyses of non-NASA mission data
    - Modeling
  - Applied Science
  - Developing technologies to improve Earth observation capabilities
  - Education and Public Outreach

# The Afternoon Constellation (“A-Train”)



**The A-Train Constellation will consist of 8 (presently 5) US and international Earth Science satellites that fly within ~10 minutes of each other making concurrent observations of many quantities. The joint measurements provide an unprecedented virtual observatory for Earth Science**



United States



Brazil



Canada



Finland



France



Japan



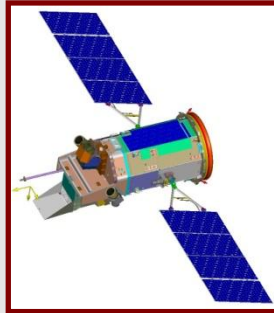
Netherlands



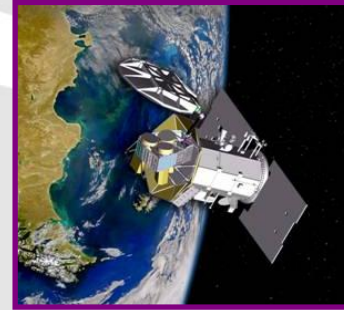
United Kingdom



# Foundational Near-Term Missions



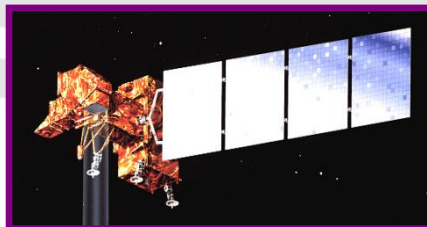
GLORY  
11/2010  
2/2011



AQUARIUS  
12/2010  
6/2011  
w/CONAE



GPM  
7/2013, 11/2014  
w/JAXA, INPE



LDCM w/TIRS  
12/2012  
w/USGS



NPP w/CERES  
NET 9/2011  
NET 10/2011, w/NOAA

# NASA Earth Science Division BUDGET MARKS: FY11 Submit



BUDGET (\$M)

